Appendix D:
Evaluation of Additional BMP Opportunities

Introduction

Aside from the BMPs addressed in Appendix C, other candidate BMPs were identified in accordance with the SWIP Objectives 1.2, 1.4, and 2.3 (see main SWIP document):

The following strategies were employed for the task:

- Utilize a BMP siting tool to identify, at a planning level, where additional BMPs can be best located to address any gaps in required pollutant load reductions.
- Utilize a GIS desktop assessment to further refine BMP siting decisions and to develop a list of new BMPs to address the TN reduction needs outlined in Appendix C.

New BMPs

Any new structural BMPs are eligible to receive load reduction credit unless they are associated with another MS4 permittee or are structural BMPs installed as part of a development project in the VSMP program. Those practices installed as part of a development project in the VSMP program will receive credit under the permit associated with the planned construction activity, but will not receive credit through the City's MS4 permit requirements.

Structural BMPs installed between January 1, 2006 and June 30, 2009 on public lands are eligible to receive full load reduction credit if they had not previously been reported to DEQ. The City does not have any BMPs that fit this classification. Any BMPs installed prior to 2006 are not eligible to receive credit, except for incremental credit associated with future BMP improvements, retrofits, and restorations. This includes several stream restoration projects that the City performed prior to 2009, such as the Downtown Harrisonburg stream bank restoration and the Fire Station #1 stream bank restoration. The original BMP functionality (pre-2006) has been incorporated into the Chesapeake Bay Watershed model baseline and is already credited by default. The Purcell Park stream restoration was completed in July 2009 but the funds used for the project came from a mitigation bank established to meet another program's reduction requirements so this stream restoration is also not eligible to receive Chesapeake Bay TMDL credits. That being said, some of the BMPs outlined above *were* eligible for credit in the local Blacks Run/Cooks Creek TMDL.

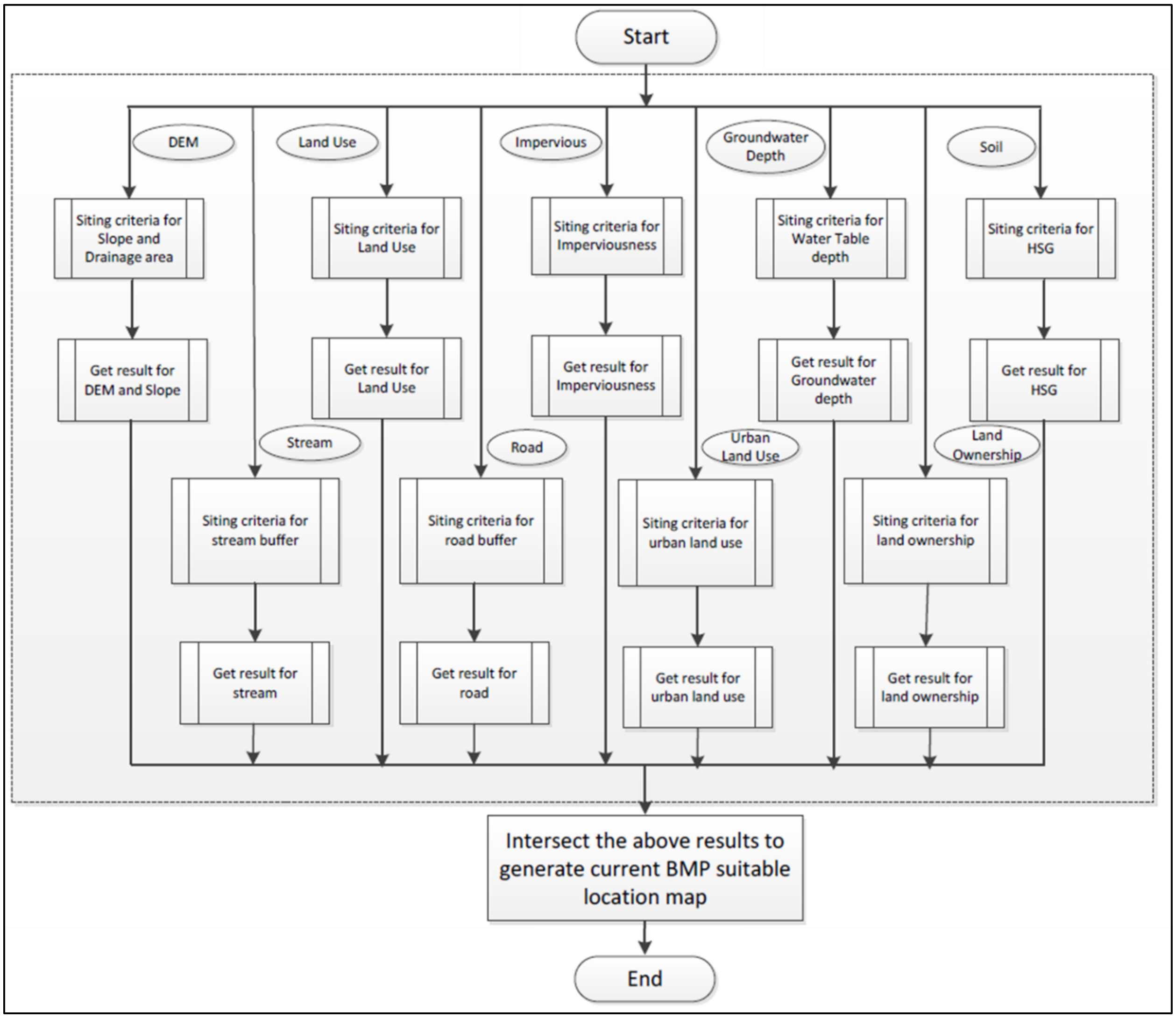
Bay Program efficiencies from CAST were used in the development of the SWIP to the extent possible to estimate potential load reductions from planned BMPs (CPB 2017). This method requires a determination of the drainage area, pervious/impervious areas, and general land use (e.g., urban, forest, agriculture) to determine a load reduction but does not require a preliminary design of each planned BMP.

BMP Siting Tool

A GIS based utility tool in the U.S. Environmental Protection Agency's (EPA's) System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) model (USEPA 2017) was used to help determine where BMPs can potentially be implemented to address the TN pollutant removal gap.

The BMP Siting Tool evaluated geospatial data to arrive at the potential BMP footprint results. Figure D-1 presents the overall data flow and processing of the tool. The tool accepts up to nine input GIS layers (ovals in Figure D-1) and applies the corresponding suitability criteria to filter those layers before intersecting with each other to highlight the locations that meet the siting criteria for the given BMP. Not all input layers are required, but more input layers yield more refined results. The accuracy of the results depends on the resolution and quality of input spatial data.

Figure D-1. Data flow chart in BMP Siting Tool.



The general methodology for using the BMP Siting Tool is:

- Select the structural BMP types for siting analysis.
- Define the site suitability criteria for each BMP type.
- Gather GIS data required for the selected site suitability criteria.
- Develop a geodatabase for the selected GIS data.
- Process GIS data to the preferred projection type and spatial extent.

- Define data layers in the “Data Management” input screen of the Siting Tool.
- Enter the site suitability criteria for each selected BMP in the input screen.
- Run the Siting Tool to produce resulting locations of recommended BMP sites.

The Siting Tool was used to select suitable locations for BMPs types—bioretention systems, vegetated filter strips, and wet ponds—using defined site suitability criteria such as slope, proximity to roads and buildings, and impervious areas. Table D-1 presents the suitability criteria for each selected BMP type, which were based on the default criteria available in the Siting Tool. The criteria were further refined using the DEQ stormwater design specification factsheets.

Table D-1. Site suitability criteria for selected structural BMP types.

	Wet Pond	Bioretention	Vegetative Filter Strip
Drainage area (acre)	> 10	< 5	< 2
Slope (%)	< 10%	< 5%	< 5%
Hydrologic soil group	C, D	A, B	A, B
Stream buffer (ft)	> 20	> 100	> 100
Building buffer (ft)	> 100	> 100	> 100
Karst area buffer (ft)	> 100	> 200	> 200
Public right-of-way (ft)	--	< 100	< 100

Wet pond criteria were also used to evaluate BMP sites for shallow marshes in the SWIP.

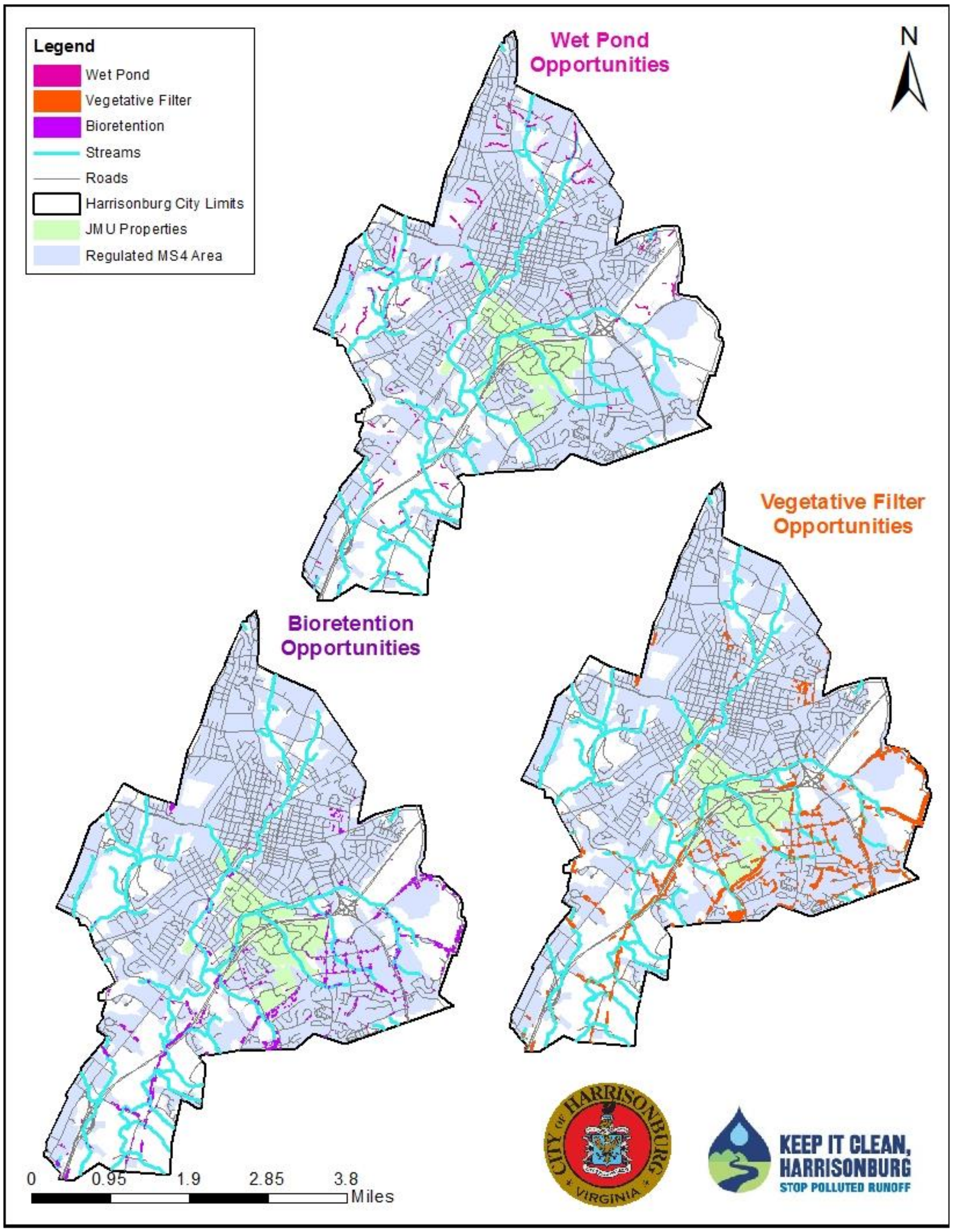
Table D-2 shows the data format of the required GIS data using the selected suitability criteria. Three-meter resolution digital elevation models (DEM) were downloaded from the U.S. Geological Survey National Elevation Dataset (USGS 2015) and soil geospatial data for the City were obtained from the U.S. Department of Agriculture’s Web Soil Survey (USDA 2017). All other GIS data layers were used from the City’s GIS data warehouse.

Table D-2. GIS data requirement for selected structural BMP types.

Layer type	Layer name	Data type	Field name	Field type	Field value
DEM	NED 1/9 arc-second	Raster	VALUE	Float	Elevation
Impervious footprints	Final_Impervious2016	Raster	VALUE	Integer	0–100
Land use	land_use_overlay_2013	Raster	VALUE	Integer	LUCODE
Karst areas	Harrisonburg DGMR Karst Reconnaissance	Raster	VALUE	Integer	LUCODE
Roads	publicrightofway	Polygon	N/A	N/A	N/A
Soil	Soil_Corrosivity_Hburg	Polygon	MUKEY	String	SSURGO map unit key
Buildings	citybuildings	Polygon	LU_DESC	String	“Buildings”
Streams	HarrisonburgStreams	Polyline	N/A	N/A	N/A
Land use lookup	LUC_Lookup	Table	LUCODE	Integer	VALUE field
			LUNAME	String	Land Use name
			SUITABLE	Short	“1” or “0” (1 = suitable; 0 = unsuitable)
Soil lookup	HSG_Lookup	Table	MUKEY	String	MUKEY field
			HYDGRP	String	“A”, “B”, “C”, or “D”

The output of the BMP Siting Tool analysis is a geospatial representation of the City that highlights the areas that meet the specified site suitability criteria for placement of the selected BMPs. These areas correspond to the area that is available for the BMP to be built, also called the BMP footprint. The Siting Tool results are highly data-driven and the accuracy of the results depends on the accuracy of underlying GIS input data. The preliminary results for wet pond, bioretention, and vegetative filter strip are shown Figure D-2. These areas were then further analyzed through a GIS desktop assessment for suitability and the preliminary results were narrowed down. For the SWIP, the Siting Tool was used to identify potential locations for BMPs throughout Harrisonburg. Areas owned by James Madison University and VDOT were not included in this analysis because they hold their own MS4 Permits.

Figure D-2. BMP Opportunities Identified by the BMP Siting Tool



Desktop Geospatial Analysis

The BMP Siting Tool identified hundreds of potential BMP footprint locations throughout the City that had to be narrowed down through a desktop assessment.

Footprints that were in the MS4 and were on government, institutional, or vacant properties were evaluated first, followed by other BMPs in the MS4 areas. Footprints were not considered if they intersected with JMU, VDOT rights of way, or existing or proposed BMPs. The footprints intersecting JMU and VDOT land were selected for elimination because they have their own MS4 permit and SWIP requirements. Properties within the City's MS4 area were selected because they receive the most credit for treated acres under the City's MS4 permit.

A desktop analysis was performed to help reduce the potential locations of the BMPs and to identify the best potential BMPs locations for the SWIP. This was completed by using additional site constraints (e.g., areas of known flooding issues) and other preferences.

The desktop analysis first looked at aerial imagery for location feasibility of each BMP to determine if it was feasible. For instance, a BMP was removed from consideration if the footprint was in a forested area or on a sports field (e.g., baseball field). Proposed BMPs were then reviewed against the existing BMP points, and proposed BMPs were removed from consideration if there was an existing BMP at that location. If the footprint location seemed feasible, then the drainage area was determined using the stormwater network and topographic contours. These BMPs were then evaluated further for inclusion in the SWIP.

BMP Load Reduction Calculations

The DEQ *Chesapeake Bay TMDL Special Condition Guidance* gives municipalities three methods for calculating the load reductions from BMPs. This SWIP uses the Chesapeake Bay Program efficiencies as the default method. The calculation is typically drainage area (acres) multiplied by the BMP efficiency multiplied by the unit loading rate (lbs/acre/yr), as defined in the City's MS4 Permit for pervious and impervious urban surfaces. There are two special circumstances in calculating these load reductions that must be accounted for: BMP treatment trains and BMPs draining unregulated areas.

- <u>BMP Treatment Trains:</u> Treatment trains occur when the treated effluent (discharge) from one BMP flows into a second BMP for additional treatment. The DEQ *Chesapeake Bay TMDL Special Condition Guidance* states that the "impact of treatment trains should also be considered by permittees" (DEQ 2015). To account for the benefits of the first BMP, the pollutant load going into the downstream BMP needs to be reduced before its load reduction is calculated. For instance, BMP A flows into BMP B. The total initial load is 10 lbs for BMP A and 20 lbs for BMP B. If the efficiency of BMP A is 50%, then there is only 5 lbs flowing out of the drainage area for BMP A instead of 10 lbs. This means that only 15 lbs is entering BMP B instead of 20 lbs, thus lowering the amount of pollutant reduction possible from BMP B. If the efficiency of BMP B is also 50%, then the City would only receive 7.5 lbs of reduction credit BMP B, instead of 10 lbs without the BMP treatment train effect.
- <u>Unregulated Areas:</u> The City must account for meeting baseline loads for BMPs installed outside the MS4 regulated area, which is defined by areas where stormwater flows to or through the City's stormwater conveyance systems (DEQ 2015). This plan mainly contains

BMPs that drain parts of the regulated areas because the City will receive more load reduction credit than BMPs that treat unregulated areas.

Overall, the additional BMP opportunities identified in this SWIP are listed in Table H-1 and summarized in Table D-3 below, matching the latest excel workbook. They address the TN load reduction gap identified in Table C-9 with a significant contingency factor of more than thirty percent. This contingency factor allows the City to choose the best projects as they take a closer look at site conditions or run into other challenges during the design, bidding, and construction of each new BMP. The additional BMPs in the SWIP offset any BMPs that are removed or revised later.

Table D-3. Summary of Identified New BMP Opportunities

BMP Type	# of Sites	Drainage Area (acres)	Impervious Drainage Area (acres)	TN Reduced (lb/yr)	TP Reduced (lb/yr)	TSS Reduced (lb/yr)
Bioretention	96	163	96	1,558	134	98,977
Regenerative Stormwater Conveyance (RSC)	1	107	47	418	54	48,010
Shallow Marsh	1	3	1	6	1	805
Veg Filter Strip	40	267	169	2,141	215	159,611
Wet Pond	7	1,317	259	1,430	213	184,901
Total	145	1,856	572	5,553	617	492,303

Figure D-3. Location of SWIP projects